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CONTRACT REQUIREMENTS FOR THE CANADIAN MINING INDUSTRY CAPITAL AND OPERATING INDICES

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by

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ABSTRACT

To enhance the mine evaluation group's capability to respond to inquiries and broaden knowledge of the Canadian mining industry, a database will be established for the compilation and display of capital and operating indices and their relationships. Forming what is to be a major part of the database will be data obtained from contracted sources. As a source of reference for the Mine Evaluation Group and as the base for the contract work statements this report presents the breakdown of data required from the contractors and other sources for the data base, and the two referral systems that will be constructed from it. The two systems are "site specific" indices (considering a mining operation's region, deposit type, mining method(s), milling method and production rate) and "rule of thumb" relationships (graphical, equation and other diagrammatic relationships) between mining/milling costs and production.

Because the database requires detailed indices, it will be difficult to obtain all the elements for this all-encompassing database; alternatives to contracting mining services consultants could lie in establishing the contracts with other sources of data gathering. The database must be updated; between updates, benchmarks need to be consulted to verify the factoring of data that has occurred from time to time.

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CONDITION DE CONTRAT POUR LES INDICES D'IMMOBILISATION ET D'EXPLOITATION DE L'INDUSTRIE MINIÈRE CANADIENNE

par

M. Bétournay* et A. Boyer*

RÉSUMÉ

Pour aider le groupe d'évaluation minière à mieux répondre aux demandes de renseignements et à mieux connaître l'industrie minière canadienne, on a établit une base de données permettant de compiler et d'afficher des indices d'immobilisation et d'exploitation et leurs relations. La plus grande partie de la base sera constituée de données fournies par des contractants. En tant que source de référence pour le Groupe d'évaluation minière et comme base pour la rédaction des contrats, le présent rapport explique le détail des données exigées des contractants ou d'autres sources, et décrit les deux systèmes de référence qui en découleront. Les deux systèmes se présentent comme des indices "spécifiques au lieu" (tenant compte de la région minière du type de gisement, ou des méthode(s) d'extraction, de la méthode de concentration et du taux de production) et des relations "empiriques" (graphiques, équations et autres diagrammes) entre les coûts d'extraction/d'affinage et la production.

Comme cette base de données générale exige des indices détaillés, il sera difficile d'en réunir tous les éléments; une solution à l'embauche d'experts-conseils en services miniers consisterait à adjuger les contrats à d'autres sources de collecte de données. La base de données doit être mise à jour; entre les mises à jour, il faut se reporter de temps à autre à des repères pour vérifier la factorisation des données.

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INTRODUCTION

Compiling relevant statistics about Canadian mines forms an integral portion of the Ministry of Energy, Mines and Resources' overview of the nature and state of the mining industry.

The geological nature of Canada is such, that widely different minerals can be found across all of its vast expanse. Although several similar deposits of any particular mineral usually occur, there exists enough variation in mining method, milling method or production rate to differentiate them.

Before gathering data for the Mine Evaluation Group's capital and operating indices data bank, certain essential points need careful examination. Firstly, it must be recognized that acquisition of detailed information from mining concerns, specifically costs, is at best difficult. This could have a bearing on the completeness and relevance of information set to be used by the Mine Evaluation Group. Secondly, for the benefit of accurate compilations, input data should not be of a subjective nature, such as feasibility or planned costs, but rather those of operating mines.

Two data referral systems will be established from the detailed database. One system will consist of presenting "site specific" capital and operating indices. This will consider the mining operation's region, deposit type, mining method(s), milling method and production rate. Costs and unit productivity are the indices presented in the first system. The second system will consist of graphical, equation and other diagramatic relationships between total, or detailed mining, milling and administrative costs versus tons per day production for one type of mineral assemblage (Pb-Zn, Au, Ni-Cu, etc.). Both local (one region) and national (Canada) basis can be used for these considerations. Thus this latter system establishes "rule of thumb" relationships.

It is clear that only one type of data is required from the mining industry indices contract(s): detailed costs and productivity figures from mining operations across Canada. Any other will not fulfill the purpose of the contract.

PURPOSE OF THE CANADIAN MINING INDUSTRY CAPITAL AND OPERATING INDICES CONTRACT

1. To obtain the capability to evaluate the various components of a mining operation for EMR policy requirements.
2. To constitute the basis for a mining industry indices data bank, updated tri-yearly and made available to government and private concerns.
3. To portray the contract results in as many relationships and manners that are useful and necessary for information dissemination.
4. To benefit the Mine Evaluation Group of MRL, CANMET, in future endeavours.
5. To derive cut-off grades and other mining considerations.

SYSTEM 1: SITE SPECIFIC CAPITAL AND OPERATING INDICES

COSTS

Every mining operation is unique: it is the interactive sum of singular mining activities. The following considerations are sufficient to separate any operation into basic categorizing factors. These are used in the decision-tree diagram portraying the route to follow in obtaining site specific costs (Fig. 1).

Factor	Based on	Refer to
1. Mining region	Transport routes; climate; type of geology; labour pools; politics.	Table 1; Fig. 2
2. Type of deposit (all except coal)	Mineral type and distribution; ore deposit size, depth, and geometry.	Table 2
3. Mining method(s) (U.G., O.P. or combined)	Mine life; ore grade and distribution; stoping equipment; hauling equipment; production rate; cash flow; ground control; regional and mine environment.	Table 3

Factor	Based on	Refer to
4. Production rate, mining	Labour pool; mining equipment; hauling equipment; ground control; cash flow; climate; milling rate.	Table 4
5. Milling method	Ore type; ore grade; capital cost; equipment; transport routes.	Table 5
6. Production rate, milling	Usually of the order of mining production rate; adjusted for week-end and holidays.	Table 4

The costs to be obtained for either system cannot be too detailed (e.g., pump costs, drill bit costs) because:

a) such detail will most likely be unavailable;
b) the goals of the program may not need such detail;
c) it would mean voluminous amounts of data to be compiled.

For these reasons the details of mining, milling and administrative activities will be limited to those presented in Table 7. Table 6 presents the total costs for those activities.

From these site specific results it is possible to add and average the costs and obtain data for specific needs such as the average costs for all mines in one region, or average costs of one mining method (all or one deposit type), etc.

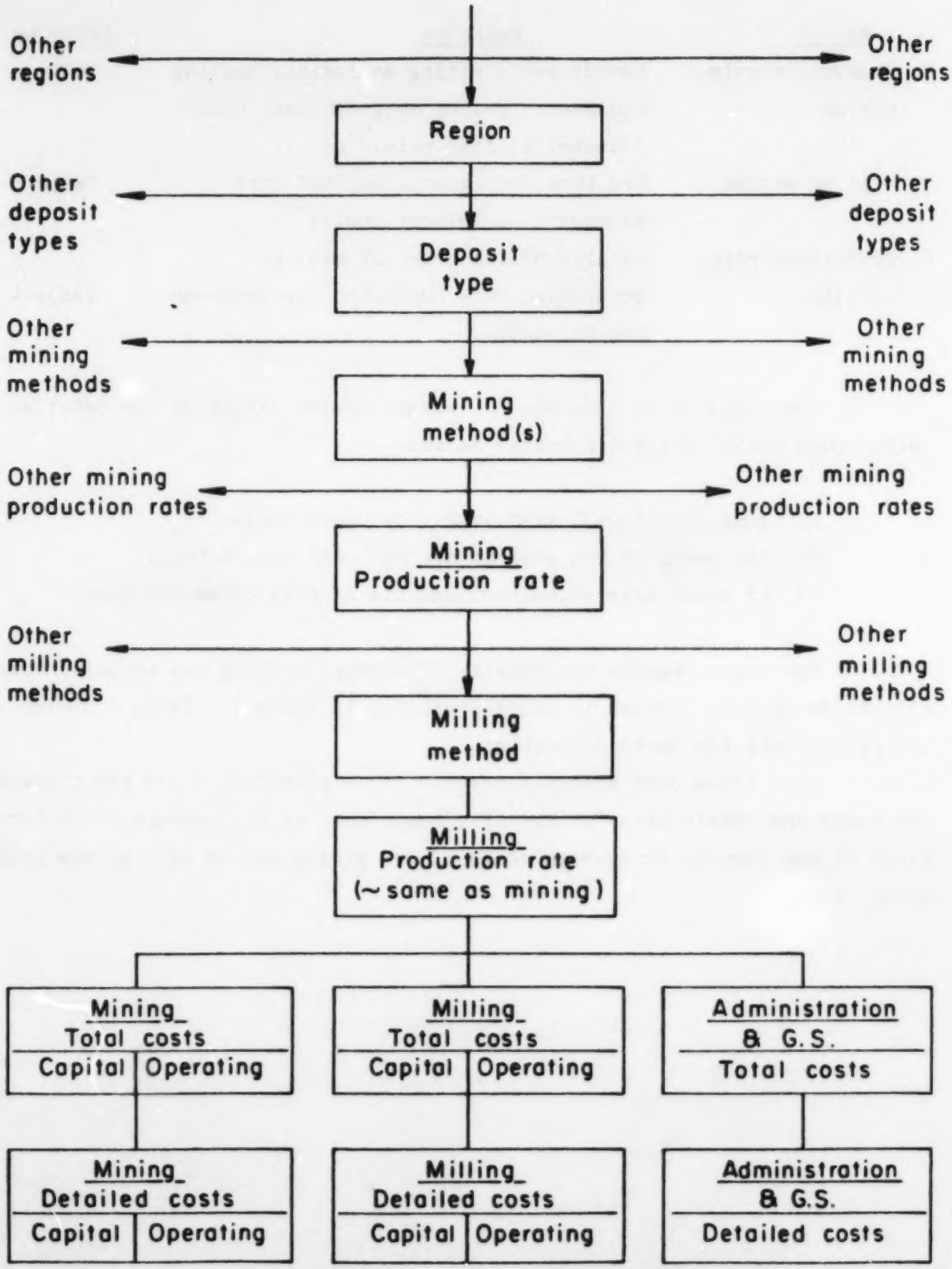


Fig. 1 - Decision tree for costs, using basic categorizing factors.

Table 1 - Canadian mining regions

1. South West, B.C.
2. Highland Valley, B.C.
3. Northern B.C.
4. Kootenay, B.C.
5. Yukon
6. Central Alberta
7. Southern Territories
8. Northern Territories
9. Athabasca, Saskatchewan
10. Southern Saskatchewan
11. Southern Manitoba
12. Flin-Flon, Thompson, Manitoba-Saskatchewan
13. Red Lake, Ontario
14. Hemlo, Manitouwadge, Ontario
15. Lakehead, Ontario
16. Wawa-Sudbury, Ontario
17. Timmins-Noranda-Val D'or, Ontario-Québec
18. Northwest Québec
19. Windsor, Ontario
20. South Grenville, Ontario-Québec
21. Thetford-Mines, Québec
22. Labrador trough, Québec - Labrador
23. Gaspé, Québec
24. Bathurst, N.B.
25. Nova Scotia
26. Western Newfoundland
27. Eastern Newfoundland

Fig. 2 - Canadian mining regions.

Table 2 - Type of deposits

Metallic

1. High grade hematite, illmenite, iron
2. Metasediment, volcanic banded iron
3. Sedimentary oolitic iron
4. Gold-quartz veins
5. Placer gold, platinum, etc
6. Mafic sill silver
7. Pegmatitic-granitic uranium, platinum and tellurides, rare earths
8. Vein pitchblende
9. Sedimentary uranium
10. Mafic-ultramafic intrusive nickel-copper
11. Orogenic interbanded mafic-felsic nickel-copper
12. Metavolcanic copper-zinc-silver-gold
13. Replacement copper
14. Volcanogenic lead-zinc-copper-iron
15. Concordant reef-sedimentary lead-zinc-silver
16. Complex vein lead-zinc-silver
17. Basic volcanics lead-zinc-copper
18. Porphyry and stockwork
19. Unclassified

Non-metallic

18. Serpentinized mafic, ultramafic asbestos
19. Talc
20. Pegmatitic, granitic, skarn: feldspar, mica, quartz, others
21. Potash
22. Salt
23. Gypsum
24. Sandstone
25. Dolomite

Table 3 - Mining methods

Underground

I) Self-Supporting Openings
- open stope
- blast hole stoping
- room and pillar
- sublevel stoping
- shrinkage stoping
- stull stoping

II) Supported Openings
- cut and fill stoping
- square set and fill stoping
- longwall mining
- shortwall mining
- top slicing

III) Caving Method
- sublevel caving
- block and panel caving

IV) Pillar Extraction
- cut and fill
- panel cut and fill
- sublevel caving
- blasthole

Open Pit

I) Single Bench
II) Multiple Bench
III) Quarrying
IV) Glory Hole

Combined

Combination of underground and open pit types.

Table 4 - Production rate categories (mine or mill)

Production	Category
Underground	
0 ➔ 1,000 t/d	1
1,000 ➔ 2,000 t/d	2
2,000 ➔ 4,000 t/d	3
>4,000 t/d	4
Open Pit	
0 ➔ 5,000 t/d	1
5,000 ➔ 15,000 t/d	2
15,000 ➔ 30,000 t/d	3
>30,000 t/d	4
Combined	
0 ➔ 3,000 t/d	1
>3,000 t/d	2

Table 5 - Milling methods (process may include one part of each of A, B, C and D)

A) Mineral Separation
   1. Flotation
   2. Gravity concentration
   3. Magnetic separation
   4. Electrostatic separation
   5. Hand sorting
   6. Other means of separation

B) Dewatering, Thermal Drying

C) Extractive Metallurgy
   1. Pyrometallurgy
   2. Hydrometallurgy
   3. Electrometallurgy
   4. Other means of extraction

D) Agglomeration
   1. Sintering
   2. Briquetting
   3. Nodulizing
   4. Other means of agglomeration

Table 6 - Summary costs for each mining activity

Mining
Total capital costs
Total operating costs
Milling
Total capital costs
Total operating costs
Administrative and General Services
Total costs

Table 7 - Detailed costs for each mining activity

I) Mining, Underground, Capital Costs (Preproduction)
- Feasibility, planning, design engineering
- Shaft sinking
- Hoisting plant
- Level development
- Stope, addit, development
- Mine compressor plant
- Utilities installation, consumption
- Underground mining equipment
- Camp/townsite
- Underground maintenance facilities
- Labour (all, including supervision, technical support)
- Administrative and key operating staff

II) Mining, Underground, Operating Costs (Production)
- Stoping (including drilling, blasting, scaling, ground control)
- Hauling
- Crushing
- Skipping, conveying
- Drifting
- Ramp, raise development
- Diamond drilling and assaying
- Other mine development
- Labour (mining, supervision, technical support)
- Lighting, ventilation, compressed air

III) Mining, Open Pit, Capital Costs (Preproduction)
- Feasibility studies, planning, design engineering
- Addit and other exploration developments
- Stripping, site preparation
- Plant and pit roads
- Compressed air plant
- Open pit equipment, sizing and costs
- Open pit maintenance facilities

Table 7 (Cont'd)

- Utilities, water installation and consumption
- Camp/townsite
- Labour (all, including supervision, technical support)
- Administrative and key operating staff

IV) Mining, Open Pit, Operating Costs (Production)

- Drilling and blasting (including ground control)
- Loading and hauling
- Crushing
- Conveying
- Ground control and pit maintenance
- Pit development (roadwork, etc.)
- Lighting, water, compressed air
- Labour (mining, supervision, technical support)

V) Mining, Combined, Capital Costs (Preproduction)

- Feasibility studies, planning, design engineering
- Stripping, site preparation
- Plant and pit roads
- Compressed air plant
- Shaft sinking
- Level development
- Stope, addit, development
- Hoisting plant
- Underground mining equipment
- Open pit equipment, sizing and costs
- Open pit maintenance facilities
- Utilities, water installation and consumption
- Camp/townsite
- Labour (all, including supervision, technical support)
- Administrative and key operating staff

Table 7 (Cont'd)

VI) Mining, Combined, Operating Costs (Production)
- Stoping (including drilling, blasting, scaling, ground control)
- Hauling
- Crushing
- Skipping, conveying
- Drifting
- Ramp, raise development
- Diamond drilling and assaying
- Other mine development
- Drilling and blasting
- Loading and hauling
- Ground control and pit maintenance
- Pit development (roadwork, etc.)
- Labour (mining, supervision, technical support)
- Lighting, ventilation, compressed air

VII) Milling, Underground, Open Pit or Combined, Capital Costs (Preproduction)
- Site clearing, excavations and foundations
- Plant constructions
- Storage bins and conveyors
- Crushers and grinders
- Flotation units
- Thickeners and filters
- Roasting, kiln units
- Loading equipment
- Utilities, water installation and consumption
- Tailings storage
- Equipment maintenance and general services
- Road construction and maintenance
- Labour (all, including supervision, technical support)

Table 7 (Cont'd)

VIII) Milling, Underground, Open Pit or Combined, Operating Costs
- Grinding agents
- Chemicals
- Filters
- Utilities and water consumption
- Labour (labourers, supervision, technical support)

IX) Administration and General Services, Underground or Open Pit
- Accounting
- Planning and design engineering
- Utility and heating consumption
- Labour

UNIT PRODUCTIVITY

Typical unit productivity types are listed in Table 8. They reflect data indicative of the development of a mine.

Table 8 - Unit productivity types

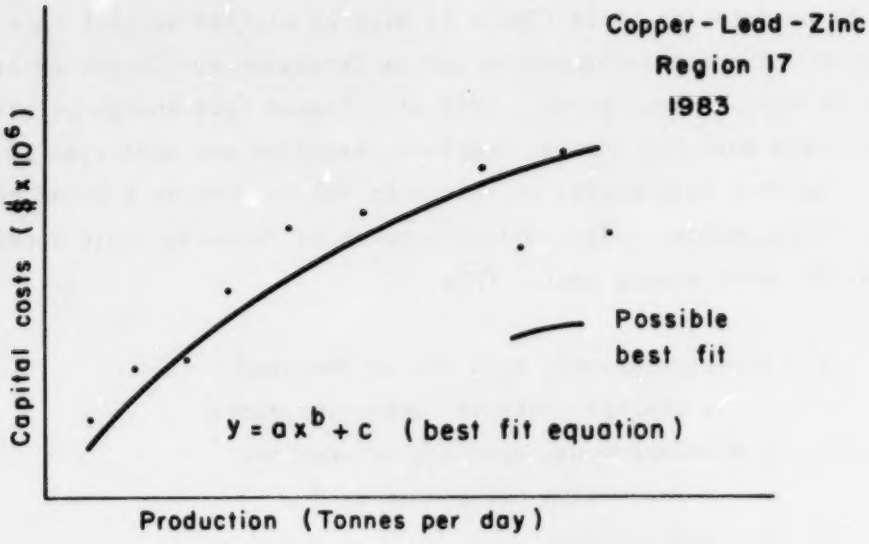
Underground
Ore Production(specified by each method and their percentage of daily production)
Tonnes ore blasted/manshift
Tonnes ore hauled/manshift
Tonnes ore hoisted/manshift
Ore Powder Factor
Waste Production
Tonnes waste blasted/manshift
Tonnes waste hauled/manshift
Tonnes waste hoisted/manshift
Waste Powder Factor
Development
Drift/ramp footage/manshift
Drift/ramp tonnes/manshift
Drift/ramp powder factor
Open Pit
Ore Production
Tonnes ore blasted/manshift
Tonnes ore hauled/manshift
Ore Powder Factor
Waste Production
Tonnes waste blasted/manshift
Tonnes waste hauled
Waste Powder Factor
Mill
Grinding consumption kg/tonnes milled
Reagent kg/tonnes milled

SYSTEM 2: SPECIFIC MINERAL GROUP, REGION, CAPITAL AND OPERATING INCIDES

As mentioned in the Introduction, the indices whether as total (Table 6) or detailed costs (Table 7) will be plotted against tons per day production. The resulting graphs can be tabulated for Canada or any region(s) and one or more mineral group. This will ensure that enough points are present to trace best fit curves/equations, examples and portrayed in Fig. 3.

Another diagramatic relationship can be used as a quick reference for general relationships. The following pairs of features could appear as "pie" diagrams for each mining region (Fig. 4):

1. For underground, open pit or combined
   - Capital costs vs. operating costs
2. For underground, open pit or combined
   - Production categories by %
3. For underground
   - Mining methods by %
4. Minerals mined, as tonnage, by %



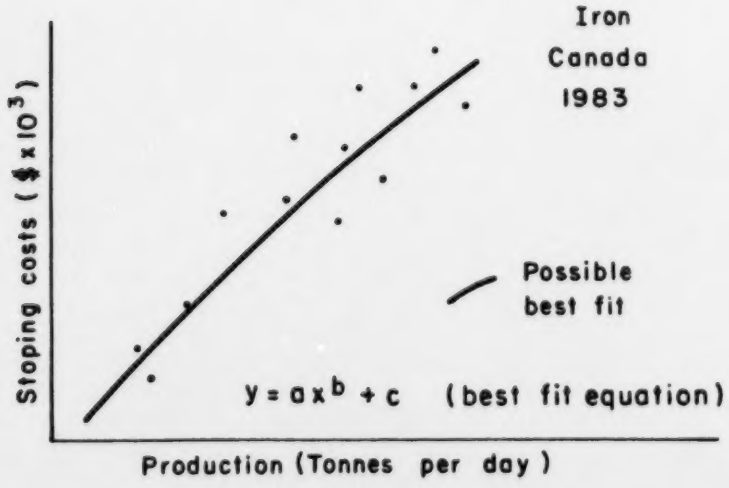
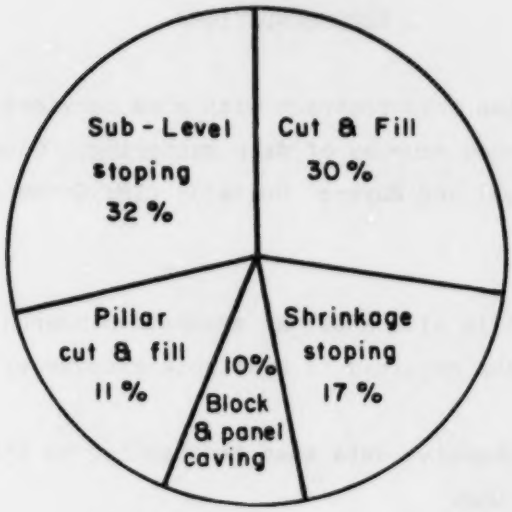


Fig. 3 - Examples of relationship types for specific mineral indices.

Region 17, Mining method 1983



Region 10, Production categories

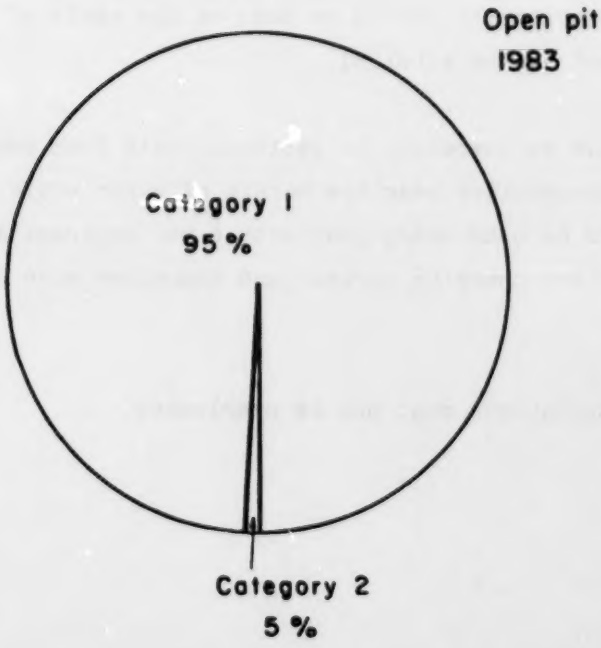


Fig. 4 - Examples of pie diagrams used to portray general relationships.

RECOMMENDATIONS

1. Rather than establish this contract with mine services consultants, allocate it to established sources of data gathering: Canadian Mining Journal (Re "Reference Manual and Buyers' Guide"); CIM; Queen's University; Mr. T. O'Hara, etc.

2. Before the contract is allocated, an exhaustive search is necessary to establish if the data required is available elsewhere.

3. Specific and comprehensive data must be supplied by the contractors, if it is to be of any use.

4. The areas not covered by one contractable source can be contracted to others.

5. Contract disbursements should be made on the basis of the amount of information that can be supplied.

6. Caution should be exercised in factoring data from one year to another: with every consecutive year the margin of error would increase. Benchmarks need to be used every year with a new contract allocated every three years to reflect changing market (and therefore mine grade) and mining methods.

7. Small mine operations must not be overlooked.